IS 12272 (1987): Divided blast cupola furnace [MTD 14: Foundry]

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(Reaffirmed 2003)

Indian Standard

SPECIFICATION FOR DIVIDED BLAST CUPOLA FURNACE

Foundry Sectional Committee, SMDC 17; Panel for Cupola for Foundries, SMDC 17/P-2 [Ref : Doc : SMDC 17 (3165)]

1. Scope — Covers recommended sizes of divided blast cupolas for use in foundries.

2. Size, Shape and Constructional Details — The recommended sizes of divided cold blast cupolas shall comply with nominal dimensions given in Table 1 (*see also* Fig. 1).

2.1 Shape and construction shall be as given in Fig. 1, read in conjunction with Table 1.

2.2 Tuyere area shall be one-fourth to one-sixth of the cross sectional area of the cupola inside the lining.

2.2.1 Since the upper tuyeres are one metre above the lower tuyeres which would normally be the position of the conventional tuyeres, the total coke bed height should be increased by about one metre above that while operating with one row of tuyeres.

2.2.2 The normal size of the tuyeres generally has little effect on cupola performance, the tuyeres in the upper row may either be of the same size as the existing tuyeres which will form the lower row on conversion, or alternately, the tuyeres size may be reduced so as to have the same total tuyere area as before. Each tuyere in both the rows of tuyeres should be fitted with an insulating valve, which when closed, will prevent cupola gases entering the wind belt during long shut down periods.

2.2.3 The two rows of tuyeres are spaced between 760 to 915 mm (30 and 36") apart (*see* Fig. 1).

2.2.4 An air inlet pipe shall be arranged tangentially to both the wind belts. Fan type blower may be used. It is recommended that a single fan or blower be used to supply air to both rows of tuyeres. However, if so required, a separate fan may be installed for the supply of air to each row of tuyeres. If a separate fan is installed for each row of tuyeres, it is necessary to ensure that adequate precautions are taken to prevent air being blown to only one row of tuyeres, causing cupola gases to be discharged into the tuyeres and wind belt system of the other row of tuyeres, creating a definite explosion risk. It is for this reason that a single fan of adequate capacity is recommended. If two fans are used, the starters should be interconnected so that it is impossible for one fan to operate without the other.

If fan type blowers of sufficient high discharge pressure are not available for larger dia cupolas, then a centrifugal positive displacement blower may be used. However, when using single speed positive displacement blower, control of the blast rate must be accomplished by means of a valve in a bleed-off duct in each of the blast mains between the blower and the wind belts to enable the excess air to be exhausted to atmosphere.

2.3 It is essential that a divided blast cupola is fitted with two rows of tuyeres such that each row of tuyeres receives an approximately equal quantity of air. For this purpose, two air measurement and control instruments are inserted in the mains supplying the blast to the cupola. The installation of simple metering equipment consisting of an orifice plate and flow indicator for each main is essential. Control of air distribution to each row of tuyeres may be done by manual operation of the isolating valves. However, as changes in the resistance to flow can cause a variation in the proportions of air supplied to each row of tuyeres, it is imperative that the cupola operator should constantly check and control the flow of blast to each row of tuyeres as this operation will essentially remain manual.

The use of automatic air-flow control instruments eliminates the dependence upon the operator to maintain the correct distribution of air to the two rows of tuyeres.

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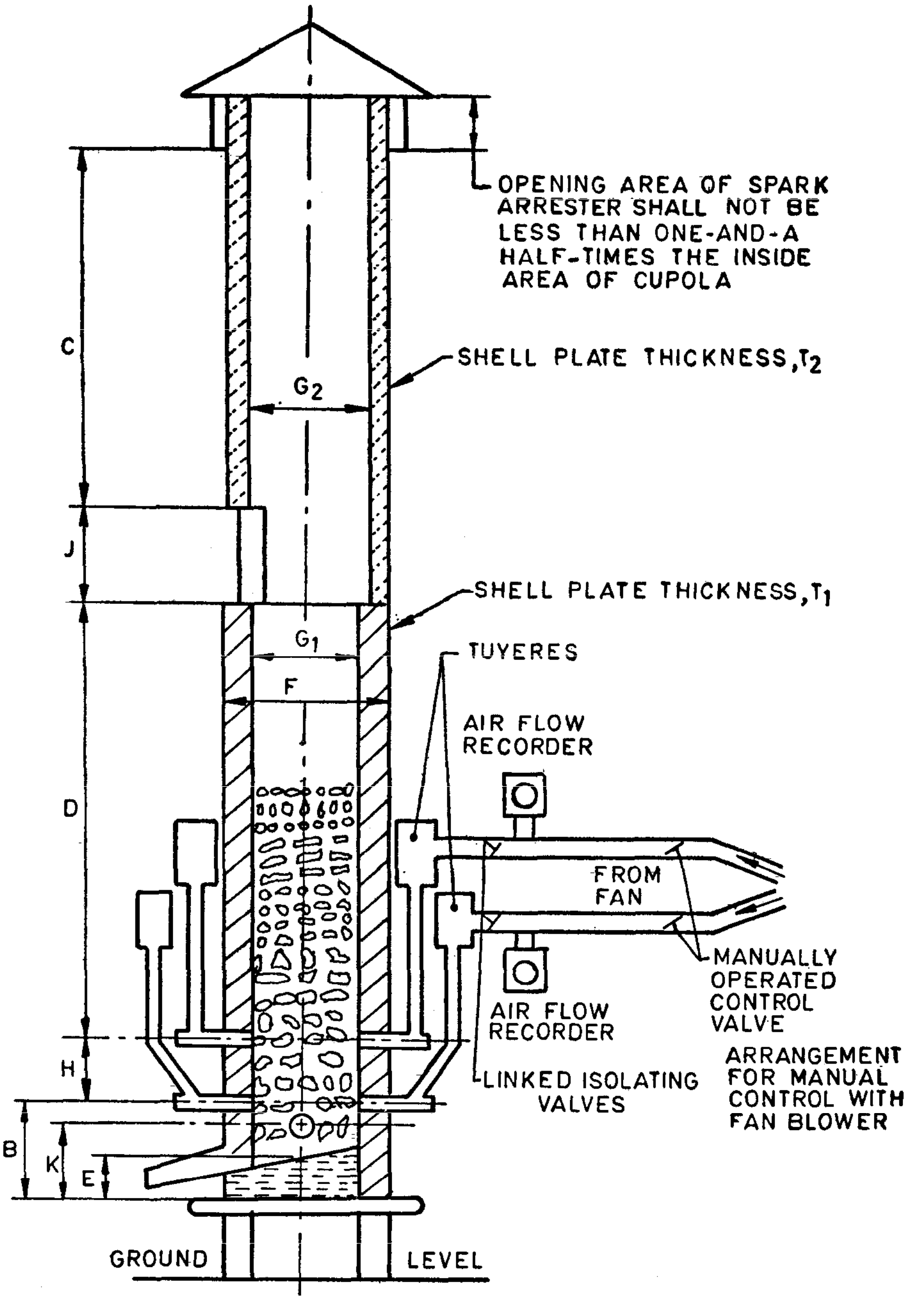
TABLE 1 RECOMMENDED DIMENSIONS FOR DIVIDED BLAST CUPOLA FURNACES

(*Clauses* 2 *and* 2.1 and *Fig*. 1)

Sl No.	Characteristic	Designation of the Furnaces										
		600	C750	C900	C1050	C1200	C1350	C1500	C1650	C1800	C1950	C2100
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1.	Cupola diameter, inside, after lining at the hearth (G_1), mm	600	750	900	1 050	1 200	1 350	1 500	1 650	1 800	1 950	2 100
2.	Cupola plan area, cm^2	2 825	4 415	6 360	8 655	11 300	14 300	17 660	21 370	25 430	29 850	34 620
3.	Shell thickness below charging door (T_1), mm	5·0	8·0	10·0	10·0	10·0	12·0	12·0	12·0	15·0	15·0	16·0
4.	Lining thickness in melting zone, mm											
	a) Short run	125	125	125	175	175	175	175	225	225	225	225
	b) Long run	150	150	150	200	200	200	200	250	250	250	250
5.	Inside diameter of cupola shell (F), mm											
	a) Short run	880	1 030	1 280	1 530	1 710	1 860	2 010	2 260	2 430	2 580	2 730
	b) Long run	930	1 080	1 330	1 580	1 760	1 910	2 060	2 310	2 480	2 630	2 780
6.	Sand filling, mm	15	15	15	15	15	15	15	15	15	15	15
7.	Split brick, mm	—	—	50	50	65	65	65	65	75	75	75
8.	Inner diameter after lining above the charging door (G_2), mm	700	850	1 000	1 200	1 350	1 550	1 700	1 900	2 050	2 200	2 350
9.	Total tuyere area, cm^2 for tuyere ratios											
	a) 1 : 3	940	1 470	2 120	2 880	3 770	4 770	5 890	7 130	8 480	9 950	11 540
	b) 1 : 4	705	1 105	1 590	2 165	2 825	3 575	4 100	5 340	6 360	7 460	8 665
	c) 1 : 5	565	885	1 270	1 730	2 260	2 860	3 530	4 275	5 085	5 970	6 240
	d) 1 : 6	470	735	1 060	1 440	1 885	2 365	2 945	3 360	4 240	4 975	5 770
10.	Number of tuyeres in each row	4	4/5	6	6/8	8	8/10	10	10	10	10/12	12
11.	Distance between upper and lower tuyeres (H), mm	760	760	760	915	915	915	915	915	1 065	1 065	1 065
12.	Height of the centre line of lower tuyeres from base plate (B), mm	700	750	800	850	900	950	1 000	1 050	1 100	1 150	1 200
13.	Effective height from upper row of tuyeres to charging door sill (D), mm	3 500	4 000	4 250	4 650	4 900	5 150	5 400	5 700	6 000	6 400	6 700
14.	Minimum height from charging door sill to cupola top without the spark arrester (C), mm	3 000	3 000	3 500	3 500	4 000	4 500	4 500	4 500	5 000	5 000	5 000
15.	Charging door dimensions (J) (approx)											
	a) Length	450	500	550	600	650	700	750	800	900	900	900
	b) Height	350	400	450	500	550	600	650	700	750	750	750
16.	Height of centre line of taphole from base plate (E), mm	150	150	175	175	200	200	225	225	250	250	275

17. Height of centre line of slag hole from base plate (for intermittently tapped cupola only) (*K*), mm	450	475	500	525	550	575	600	625	650	675	700
18. Blast pipe diameter, mm	200	250	300	350	400	450	500	550	660	660	700
19. Size of wind box for each row											
a) Radial width, mm	200	250	300	325	350	375	400	425	450	475	500
b) Height, mm	500	625	750	875	1 050	1 125	1 200	1 275	1 350	1 425	1 500
20. Motor power											
a) HP	7·5	10·0	18·0	25·0	35·0	45·0	60·0	70·0	85·0	100·0	120·0
b) kW	5·6	7·5	13·5	19·0	26·0	33·0	45·0	52·0	63·4	74·6	90·0
21. Melting rate (t/h) for divided blast cupola converted from cold blast cupolas of following specific melting rates:											
a) 8·00 (t/m²)/h	3·0	4.2	6·0	8·4	10·8	13·8	16·8	20·4	24·6	28·8	33·6
b) 6·50 (t/m²)/h	2·4	3·6	4·8	6·6	9·0	11·4	13·8	16·8	19·8	23·4	27·0
c) 4·80 (t/m²)/h	1·8	2·4	3·6	4·8	6·6	8·4	10·2	12·6	15·0	17·4	20·4
22. Blast pressure WG (cm) at specific melting rates of 7·8 (t/m²)/h and above, at coke metal ratios:											
a) 1 : 5	72	81	87	97	103	110	119	125	131	140	146
b) 1 : 6	59	64	69	72	75	81	84	89	94	100	104
c) 1 : 7	50	54	56	60	62	65	68	72	75	78	80
d) 1 : 8	43	46	48	50	52	54	56	58	60	62	64
23. Blast pressure WG (cm) at specific melting rates of less than 7·8 (t/m²)/h at coke metal ratios:											
a) 1 : 5	67	75	81	88	94	100	108	114	120	126	133
b) 1 : 6	58	61	65	68	72	76	80	84	88	92	95
c) 1 : 7	48	51	55	57	60	62	65	68	70	72	—
d) 1 : 8	43	45	47	50	51	53	55	56	58	60	—
24. Blast volume, m³/min, at specific melting rates 7·8 (t/m²)/h and above, at coke metal ratios:											
a) 1 : 5	53	65	97	132	166	219	268	308	357	414	467
b) 1 : 6	49	57	81	114	154	191	235	276	317	378	426
c) 1 : 7	32	42	68	93	130	168	212	255	303	350	400
d) 1 : 8	25	33	54	80	118	158	196	240	280	325	377
25. Blast volume, m³/min, at specific melting rates less than 7·8 (t/m²)/h at coke metal ratios:											
a) 1 ; 5	45	55	70	90	112	148	188	230	275	317	365
b) 1 : 6	40	45	60	75	100	132	170	210	250	295	340
c) 1 : 7	32	35	46	65	89	115	146	185	225	266	310
d) 1 : 8	25	27	40	55	75	102	131	170	207	245	285



B = Height of centre line of lower row of tuyeres from base plate
C = Height of shell from sill end to the top of cupola without the spark arrester
D = Effective height
E = Height of centre line of tap hole from base plate
F = Inner diameter of shell
G_1 = Inner diameter after lining below the charging door
G_2 = Inner diameter after lining above the charging door
H = Distance between upper and lower row of tuyeres (for intermittently tapped cupolas only)
J = Size of charging door
K = Height of centre line of slag hole from base plate
T_1 = Thickness of shell plate below the charging door
T_2 = Thickness of shell plate above the charging door

FIG. 1 CONSTRUCTIONAL DETAILS FOR DIVIDED BLAST CUPOLA FURNACE

2.4 Fig. 2A shows how the air delivered from a single fan can be fed into two mains, each leading to its own wind belt. One of these wind belts shall supply air to the upper tuyeres and the other to the lower tuyeres. If the divided blast is to be supplied to a pair of cupolas, only one of which is operating at any particular time, then an arrangement of mains similar to that shown in Fig. 2B may be used.

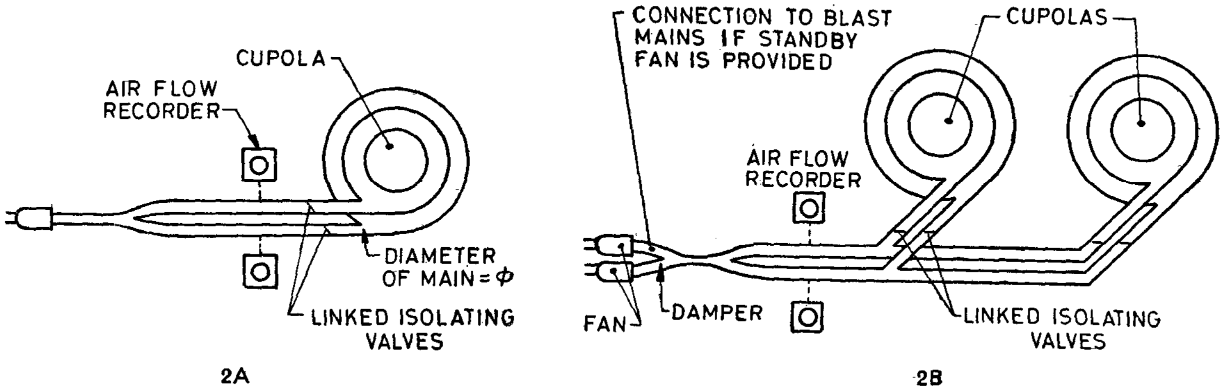


FIG. 2 LAYOUT OF BLOWERS MAINS AND CONTROL INSTRUMENT FOR OPERATION WITH DIVIDED BLAST CUPOLA FURNACE

Where a standby fan is available, the outlets from both the fans should be fed into a common blast main before dividing the blast to separate wind belts, as shown in Fig. 2B. Divided blast cupola design shall always incorporate normal safety features to guard against possible explosions occurring as a result of cupola gases entering the tuyeres, wind belt and blast mains during blast-off periods. When changing to two rows of tuyeres, explosion doors, check valves, tuyere cover, flap and tuyeres elbow valves should be installed in such a way as to safeguard both the blast mains and both the windbelts involved.

In both cases, it is recommended that the isolating valves in the upper and lower blast mains of each cupola shall have a common linkage, thereby allowing the air blast to the upper and lower tuyeres to be shut off or applied simultaneously.

2.5 The divided blast cupola improves the efficiency of the cupola operation and (a) a higher metal tapping temperature and a higher carbon pick up can be obtained for a given coke consumption, or (b) the coke consumption can be appreciably reduced and melting capacity increased for a given temperature.

2.6 While constructing the shell of the cupola, the brick retaining rings shall be riveted around the inside of the shell below and above the charging door to help in keeping the brick lining in place.

2.6.1 The size of the brick retaining rings below the charging door shall be at a distance of 1 200 mm above the upper tuyeres and subsequently after every 1 200 mm height. The size of brick retaining rings above the charging door shall be 100 mm wide and 16 to 25 mm thick according to the size of cupola and these rings shall be placed 1 200 mm apart.

2.7 In building the lining for cupola diameters up to 750 mm, the fire bricks shall be about 12 mm clear of the cupola shell and this space shall be filled with sand or genister as the work proceeds. For larger cupola furnaces, split bricks of thickness ranging from 50 to 75 mm shall be used in between the lining and the sand filling.

2.8 To protect the lining, cast iron blocks shall be provided just below the charging door.

2.9 The thickness of shell above the charging door may range between 5 and 10 mm according to the size of cupola.

2.9.1 The material used for shell shall be of mild steel conforming to IS : 226-1975 'Specification for structural steel (standard quality) (*fifth revision*)'.

2.10 A suitable stack level indicator mechanism may be provided as agreed to between the manufacturer and the user.

2.11 The minimum height of the supporting column from ground level to base plate shall be decided so that the drop bottom opens freely and unused material is discharged freely.

2.12 For the provision of a suitable dust collector, the height of the cupola shell above the charging door may be modified.

EXPLANATORY NOTE

This standard on divided blast cupola has been formulated, based on the development of this type of cupola by B. C. I. R. A., United Kingdom.

This standard describes the design of divided blast cupolas and modification to the existing cupolas which can be carried out for coversion to divided blast operation. The purpose of this standard is to guide the designers of cupolas and to assist the foundries to make the necessary alterations to their existing cupola installations to derive the advantages of divided blast operation. These are as follows:

a) Reduction in coke consumption of about 20 percent for same tapping temperature,

b) Increase in melting rate with same coke consumption,

c) Divided blast without reduced charge coke consumption can give an increase in tapping temperature of up to 50°C, and

d) The reduced coke charge enables output rates to be increased up to 10 percent without increasing the normal blast rate.

Divided blast cupolas are not suitable for melts of shorter duration, that is, less than two hours as the saving in charge coke may not compensate for the additional quantity of bed coke required.

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